FORM PTO-1390
(REV 10-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER
FNL6318P0010US

U.S. APPLICATION NO (If known, see 37 CFR 1 5)
10/048077

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB00/03006	04 Aug. 2000 (04.08.2000)	06 Aug. 1999 (06.08.1999)

TITLE OF INVENTION CODED LABEL INFORMATION EXTRACTION METHOD

APPLICANT(S) FOR DO/EO/US Matthewson, Peter

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☑ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☑ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☐ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☑ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto (required only if not communicated by the International Bureau).
   b. ☑ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☑ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☑ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 16 below concern document(s) or information included:

11. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☑ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☑ Other items or information:
    a. Copy of International Publication No. WO 01/11541 A1;
    b. Copy of International Search Report, as included in item 16a;
    c. Copy of International Preliminary Examination Report with annex(es);

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No. EV 033932490US

531 Rec'd PCT/PTO 23 JAN 2002

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 10/048077	INTERNATIONAL APPLICATION NO PCT/GB00/03006	ATTORNEY'S DOCKET NUMBER FNL6318P0010US

				CALCULATIONS	PTO USE ONLY
17. ☑ The following fees are submitted: **BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :** Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO .... **$1000.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO....... **$860.00** International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO .... **$710.00** International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) .... **$690.00** International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**					
ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 860.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☑ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$ 130.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	-30- - 20 =	-10-	X **$18.00**	$ 180.00	
Independent claims	-1- - 3 =	-0-	X **$80.00**	$ 0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$270.00**	$ 270.00	
TOTAL OF ABOVE CALCULATIONS =				$ 1,310.00	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$ 0.00	
SUBTOTAL =				$ 1,310.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ 0.00	
TOTAL NATIONAL FEE =				$ 1,310.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ 0.00	
TOTAL FEES ENCLOSED =				$ 1,310.00	
				Amount to be refunded:	$
				charged:	$

a. ☑ A check in the amount of $ 1,310.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. ______ in the amount of $______ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☑ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 04-1644. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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24,103

REGISTRATION NUMBER

10/048077

531 Rec'd PCT/PTC 23 JAN 2002

#4/a

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
ACTING AS THE UNITED STATES DESIGNATED/ELECTED OFFICE

Applicant (for US):	Peter Matthewson	)
		)
Application No.:	PCT/GB00/03006	)
		)
Int. Filing Date:	04 August 2000	)
		)
Priority Date:	06 August 1999	)
		)
Docket No.:	FNL6318P0010US	)

FIRST PRELIMINARY AMENDMENT
UPON ENTRY INTO NATIONAL STAGE

Box PCT
Commissioner for Patents
Washington, D.C. 20231

Sir:

You are requested to amend claims 3, 4, 5, 9, 10, 14, 15, 17, 18, 20, 21, 22, and 23 and add claim 24, so that claims 1 through 24 read as follows:

1. A method of decoding an information carrier comprising a plurality of magnetic elements supported by, or incorporated in, a substrate, wherein the elements are of substantially the same width and wherein the relative positions of said magnetic elements represents the information encoded by the information carrier, the method comprising the steps of:

i) applying an interrogation signal to the information carrier so that each of the magnetic elements are subjected, in turn, to the interrogation signal;
ii) detecting the response signal of each of the magnetic elements to said interrogation signal;

iii) processing each response signal detected in ii) so as to determine an estimate of the relative velocity between the interrogation signal and each of the magnetic elements; and

iv) estimating the dynamics of motion between the interrogation signal and the information carrier, by consideration of the processed signals obtained in iii), so as to determine the relative positions of the magnetic elements.

2. A method according to claim 1, wherein said magnetic elements comprise high permeability, low coercivity material having an easy axis of magnetisation.

3. (Amended) A method according to claim 1, wherein said interrogation signal comprises regions of high saturating magnetic field contiguous with regions of zero magnetic field.

4. (Amended) A method according to claim 1, wherein the frequency of the detected response generated by said magnetic elements is a harmonic of the interrogation signal.

5. (Amended) A method according to claim 1, wherein the frequency of the detected response generated by said magnetic elements is the second harmonic of the interrogation signal.

6. A method according to any claim 4 or 5, wherein a graphical representation of the response signal is obtained by plotting the amplitude of the detected signal against time, wherein the presence of a magnetic element is indicated by two half peaks of opposite polarity in the detected response signal.

7. A method according to claim 6, wherein the half peaks in the detected response signal are identified by the following steps:

i) obtaining a contiguous set of sample points from the detected response signal;

ii) sorting the samples points into an order of ascending magnitude;

iii) finding the median value from the sorted samples and subtracting this value from each of the sample points;

iv) testing the sample points in order to identify the peaks, wherein a positive polarity half peak is identified by the presence of lower magnitude signals either side of the signal point being tested, and a negative polarity half peak is identified by the presence of higher magnitude signal either side of the signal point being tested.

8. A method according to claim 7, wherein the relative velocity between the interrogation signal and each of the magnetic elements is determined by:

i) determining the two positions either side of the peak at which the amplitude of the detected response signal is a predetermined fraction of the peak amplitude value; and

vi) determining the distance between these two positions to give the half peak width.

9. (Amended) A method according to claim 7, wherein an estimate of the relative velocity between the interrogation signal and the information carrier during its interaction with each of the magnetic elements is determined by measuring the separation between the two half peaks of opposite polarity.

10. (Amended) A method according to claim 1, wherein the frequency of the detected response generated by said magnetic elements is the fundamental frequency of the interrogation signal.

11. method according to claim 10, wherein a graphical representation of the response signal is obtained by plotting the amplitude of the detected signal against time, wherein the presence of a magnetic element is indicated by a peak in the detected response signal.

12. A method according to claim 11, wherein the peaks in the detected response signal are identified by the following steps:

i) obtaining a contiguous set of sample points from the detected response signal;

ii) sorting the samples points into an order of ascending magnitude;

iii) finding the median value from the sorted samples and subtracting this value from each of the sample points;

iv) testing the sample points in order to identify the peaks, wherein a peak is identified by the presence of lower magnitude signals either side of the signal point being tested.

13. A method according to claim 12, wherein an estimate of the relative velocity between the interrogation signal and each of the magnetic elements is determined by:

i) determining the two positions either side of the peak at which the amplitude of the detected response signal is a predetermined fraction of the peak amplitude value; and

ii) determining the distance between these two positions to give the peak width.

14. (Amended) A method according to claim 8, wherein the velocity of the interrogation signal, with respect to each magnetic element, is determined from the values of each of the [peak or] half peak widths.

15. (Amended) A method according to claim 8, wherein the velocity function of the interrogation signal is modelled by a polynomial function, the coefficients of which are determined by the estimates of the velocity of the interrogation signal at each magnetic element.

16. A method according to claim 15, wherein said mathematical function is integrated with respect to time so as to determine the size of the gaps between each of the magnetic elements.

17. (Amended) A method according to claim 16, wherein the size of the measured gaps between each adjacent pair of magnetic elements are modelled by A + mG, wherein A is a first fixed value; m is an integer (which may be zero); and G is a second fixed value.

18. (Amended) A method according to claim 1, further comprising the step of decoding a variation in length of the magnetic elements, wherein the amplitude of the detected signal response is directly related to the length of the element.

19. A method according to claim 18, wherein the length of at least one of the magnetic elements is or are known, thereby acting as a reference element, with respect to which the lengths of the other magnetic elements can be determined.

20. (Amended) A method according to claim 15, further comprising the step of determining an error metric of the velocity function.

21. (Amended) A method according to claim 15, further comprising the step of determining an error metric of the measured gaps between the magnetic elements compared with the gap widths as modelled by A+ mG where m is a decoded integer from each measured gap.

22. (Amended) A method according to claim 15, further comprising the step of determining an error metric of the amplitude of the magnetic response.

23. A method according to any one of claims 20, 21 or 22, wherein the decoded information is rejected if the error metric is found to be higher than a threshold level.

24. (New) A method according to claims 13, wherein the interrogation signal, with respect to each magnetic element, is determined from the values of each of the peak widths.

You also are requested to enter the appended Abstract, which is typed on a separate page, as required.

Respectfully submitted,

By Allen J. Hoover

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January 23, 2002

10/048077
531 Rec'd PCT/PTO 23 JAN 2002

VERSION WITH MARKINGS TO INDICATE CHANGES MADE

1. A method of decoding an information carrier comprising a plurality of magnetic elements supported by, or incorporated in, a substrate, wherein the elements are of substantially the same width and wherein the relative positions of said magnetic elements represents the information encoded by the information carrier, the method comprising the steps of:

i) applying an interrogation signal to the information carrier so that each of the magnetic elements are subjected, in turn, to the interrogation signal;

ii) detecting the response signal of each of the magnetic elements to said interrogation signal;

iii) processing each response signal detected in ii) so as to determine an estimate of the relative velocity between the interrogation signal and each of the magnetic elements; and

iv) estimating the dynamics of motion between the interrogation signal and the information carrier, by consideration of the processed signals obtained in iii), so as to determine the relative positions of the magnetic elements.

2. A method according to claim 1, wherein said magnetic elements comprise high permeability, low coercivity material having an easy axis of magnetisation.

3. (Amended) A method according to claim 1 [or 2], wherein said interrogation signal comprises regions of high saturating magnetic field contiguous with regions of zero magnetic field.

4. (Amended) A method according to <u>claim 1</u> [any preceding claim], wherein the frequency of the detected response generated by said magnetic elements is a harmonic of the interrogation signal.

5. (Amended) A method according to claim 1 [any preceding claim], wherein the frequency of the detected response generated by said magnetic elements is the second harmonic of the interrogation signal.

6. A method according to any claim 4 or 5, wherein a graphical representation of the response signal is obtained by plotting the amplitude of the detected signal against time, wherein the presence of a magnetic element is indicated by two half peaks of opposite polarity in the detected response signal.

7. A method according to claim 6, wherein the half peaks in the detected response signal are identified by the following steps:

i) obtaining a contiguous set of sample points from the detected response signal;

ii) sorting the samples points into an order of ascending magnitude;

iii) finding the median value from the sorted samples and subtracting this value from each of the sample points;

iv) testing the sample points in order to identify the peaks, wherein a positive polarity half peak is identified by the presence of lower magnitude signals either side of the signal point being tested, and a negative polarity half peak is identified by the presence of higher magnitude signal either side of the signal point being tested.

8. A method according to claim 7, wherein the relative velocity between the interrogation signal and each of the magnetic elements is determined by:

i) determining the two positions either side of the peak at which the amplitude of the detected response signal is a predetermined fraction of the peak amplitude value; and

vi) determining the distance between these two positions to give the half peak width.

9. (Amended) A method according to claim [6 or] 7, wherein an estimate of the relative velocity between the interrogation signal and the information carrier during its interaction with each of the magnetic elements is determined by measuring the separation between the two half peaks of opposite polarity.

10. (Amended) A method according to <u>claim 1</u> [any one of claims 1,2 or 3], wherein the frequency of the detected response generated by said magnetic elements is the fundamental frequency of the interrogation signal.

11. A method according to claim 10, wherein a graphical representation of the response signal is obtained by plotting the amplitude of the detected signal against time, wherein the presence of a magnetic element is indicated by a peak in the detected response signal.

12. A method according to claim 11, wherein the peaks in the detected response signal are identified by the following steps:

i) obtaining a contiguous set of sample points from the detected response signal;

ii)sorting the samples points into an order of ascending magnitude;

iii) finding the median value from the sorted samples and subtracting this value from each of the sample points;

iv) testing the sample points in order to identify the peaks, wherein a peak is identified by the presence of lower magnitude signals either side of the signal point being tested.

13. A method according to claim 12, wherein an estimate of the relative velocity between the interrogation signal and each of the magnetic elements is determined by:

i) determining the two positions either side of the peak at which the amplitude of the detected response signal is a predetermined fraction of the peak amplitude value; and

ii) determining the distance between these two positions to give the peak width.

14. (Amended) A method according to <u>claim 8</u> [any one of claim 6 to 13], wherein the velocity of the interrogation signal, with respect to each magnetic element, is determined from the values of each of the [peak or] half peak widths.

15. (Amended) A method according to <u>claim 8</u> [any preceding claim], wherein the velocity function of the interrogation signal is modelled by a polynomial function, the coefficients of which are determined by the estimates of the velocity of the interrogation signal at each magnetic element.

16. A method according to claim 15, wherein said mathematical function is integrated with respect to time so as to determine the size of the gaps between each of the magnetic elements.

17. (Amended) A method according to <u>claim 16</u> [any preceding claim], wherein the size of the measured gaps between each adjacent pair of magnetic elements are modelled by A + mG, wherein A is a first fixed value; m is an integer (which may be zero); and G is a second fixed value.

18. (Amended) A method according to <u>claim 1</u> [any preceding claim], further comprising the step of decoding a variation in length of the magnetic elements, wherein the amplitude of the detected signal response is directly related to the length of the element.

19. A method according to claim 18, wherein the length of at least one of the magnetic elements is or are known, thereby acting as a reference element, with respect to which the lengths of the other magnetic elements can be determined.

20. (Amended) A method according to claim 15 [any one of claims 15 to 18], further comprising the step of determining an error metric of the velocity function.

21. (Amended) A method according to claim 15 [any one of claim 17], further comprising the step of determining an error metric of the measured gaps between the magnetic elements compared with the gap widths as modelled by A+ mG where m is a decoded integer from each measured gap.

22. (Amended) A method according to claim 15 [any one of claims 15 to 18], further comprising the step of determining an error metric of the amplitude of the magnetic response.

23. A method according to any one of claims 20, 21 or 22, wherein the decoded information is rejected if the error metric is found to be higher than a threshold 35 level.

24. (New) A method according to claims 13, wherein the interrogation signal, with respect to each magnetic element, is determined from the values of each of the peak widths.

ABSTRACT

In a method of interpreting coded information carriers, a plurality of magnetic elements supported by, or incorporated in, a substrate, are interrogated. The relative positions and/or physical dimensions of the magnetic elements represent the information encoded by the information carrier. The relative positions and/or physical dimensions are determined from the relative velocity between an interrogating signal and each of the magnetic elements.

CODED LABEL INFORMATION EXTRACTION METHOD

The present invention relates to methods of interpreting coded information carriers and to methods of processing the response of such carriers to an interrogating magnetic field.

In certain types of human and machine-readable information-bearing label, a set of elements is used to represent the information contained in the label. This representation may be made by varying the characteristics of the elements comprising the label, and also by the position in which the label elements are placed. Reading apparatus senses the characteristics and placement of the elements in order to decode the information contained within the label. The elements in the label are sequentially scanned, to discover the presence of the constituent elements and to measure their characteristics and position and thence to decode the information contained by the label.

This application describes label decoding methods by which information represented on such a label can be decoded. Typical label embodiments are where the label is manufactured from a plurality of magnetically active elements supported on a substrate. Information is coded by controlling the relative positions. Independent control of the physical properties of the elements, such as shape may also be used.

In alternative embodiments, information may be coded by controlling the relative angles of orientation of the easy axis of the magnetic elements and in some cases element shape some other physical property can be independently controlled to further encode the information carrier.

In certain types of label decoding system a label consisting of a set of elements is scanned, that is the

elements are activated in turn by applying a signal to which the scanned element responds, and to which the reading apparatus is sensitive. Either or both of the means of generating the scanning signal, and the means of generating the received signal in the reading apparatus select a single elements in turn so that the signal from a particular element may be resolved from that of the other elements.

According to one aspect of the present invention there is provided a method of decoding an information carrier comprising a plurality of magnetic elements supported by, or incorporated in, a substrate, wherein the relative positions and/or physical dimensions of said magnetic elements represents the information encoded by said information carrier, the method comprising the steps of:

i) applying an interrogation signal to each of the elements of said information carrier;

ii) detecting the response of said magnetic elements to said interrogation signal;

iii) processing the response detected in ii) so as to determine an estimate of a mathematical function which defines the relative velocity between the interrogating signal and each of the magnetic elements, from which the relative positions and/or the relative physical dimensions can be determined.

Conveniently, detection of the magnetic response of said magnetic elements may comprise observation of harmonics which are generated by the magnetic element from an applied AC field as its magnetic state is altered by the interrogating magnetic field. The presence of a magnetic element, and details of the physical dimensions of the magnetic element, can advantageously be identified in a plot of the detected amplitude of the harmonic signal. The presence of a set of signals in the otherwise quiescent detected signal

indicates the issuance of harmonic signal by a magnetic element as its magnetic properties are active. The means of scanning may be automatic by electronically scanning the interrogating signal and the receive sensitivity along the label or by an automatic mechanism causing the label elements to be interrogated in turn. Alternatively the scanning may be manually operated where the label is moved past the reading apparatus by hand, or alternatively the reading apparatus or part thereof may be moved past the label by hand.

Information may be advantageously encoded into the label by varying either the length of the material elements, that is the size of the element normal to the longitudinal axis of the label, or the width of the elements. By maintaining the element width constant, variations in element length predominantly cause a change in amplitude of the received signal which can be detected in order to recognise additional coded information.

For a better understanding of the present invention and to show how the same maybe carried into effect, reference will now be made by way of example to the accompanying drawings in which:

Figure 1a shows a coded information carrier according to the present invention;

Figure 1b shows the variation in amplitude of the second harmonic frequency as the information carrier is subjected to an interrogating magnetic field;

Figure 1c shows the receive signal from a single magnetic element;

Figure 1d shows the received fundamental signal from three magnetic elements;

Figure 2a shows the relative variation of the received second harmonic signal with element length;

Figure 2b shows the relative variation of received fundamental signal with element length;

Figure 3a show a coded information carrier according to the present invention, wherein the magnetic element are length coded;

Figure 3b shows the receive signal from an information carrier having length coding;

Figure 4a shows the positions of the half peaks of the detected signal shown in Figure 3b;

Figure 4b shows the magnitude of the double peaks in amplitude units;

Figure 4c shows a plot of the double peak separations versus double peak position;

Figure 4d shows a plot of the velocity estimates of selected points versus time;

Figure 4e shows the resultant fit of gap number to integer grid.

Fig 1a shows a plan view of a label 1 comprising a plurality of magnetic elements 2. The elements are made out of high permeability, low coercivity magnetic thin film material such as Atalante manufactured by IST(Belgium). In this particular example the elements are substantially equal in size and have dimensions of 1mmx1.5mm. The easy axis of the material is arranged so as to be parallel with the longitudinal axis of the label.

In order to interrogate the label 1, a reading antenna is passed by the label subjecting each element in turn to a region of null magnetic field formed by a permanent magnet arrangement. That is a magnetic field comprising regions of high saturating magnetic field contiguous with regions of zero magnetic field. A superimposed high frequency field, in this case 6.348 kHz, causes the material element to switch when it is present in the magnetic null. In other words the

element is driven over its B-H loop as it passes through the zero magnetic field region. A receive coil is used to detect the harmonic signals resulting from the element switching, and the received harmonic signal is mixed to baseband and filtered prior to digitisation.

Figure 1b shows a typical signal received from such a label, wherein the read head is passed in proximity with the information carrier and is arranged to detect the second harmonic of the element switching signals. The signal from a single element is shown in Fig 1c which shows two half peaks 4 and 5 of opposite sign with a zero crossing. It can be seen that the label signal approximates a superposition of single element responses at each position in which there is an element.

The signal is sampled with a fixed sample rate, and converted to a digital representation in an analogue to digital converter. The sample rate must be fast enough to capture the signal information in accordance with the Nyquist criterion, preferably with anti-aliasing filtering prior to the sampling operation.

The sample number of the centre of each element response depends upon the time at which the element passed the read head.

In addition, the width of the element response depends upon the speed at which the element passed the read head. Information about the dynamics of the relative motion of the tag and the read head can therefore be inferred from measuring the width of the signal. This can be achieved by measuring the width of the positive going and negative going peak associated with the element. It can also be achieved by measuring the separation between the positive and negative going peaks. This speed estimate is fundamental to estimates

of the dynamics of motion and allows the information in the label to be decoded reliably without compromising the available code space by adding regular features in the label.

In alternative implementations of the reading apparatus, the scanning motion of the magnetic null relative to the label may be achieved by electronically scanning using a set of excitation coils that are driven in a phased manner so as to cause the magnetic null to propagate in space. The null may be scanned at a speed which allows the switching of the label elements to be detected directly from the receive coils without needing to superimpose a separate high frequency excitation field. In this case the material element response coupled into the receiver is a single peak.

Fig 1d shows 3 adjacent peaks 6, 7 and 8 of the fundamental signal from 3 magnetic elements recorded from a reading system employing electronic scanning. In this case the width of the response from each magnetic element can be used to provide an estimate of the velocity of the scanning null as it passed over the element being scanned. This information can be used to estimate the detailed dynamics of motion and the errors arising from the system and also from misalignment of the label with respect to the nominal read axis of the read head.

Information can be encoded into the label by varying the length of the material elements, that is the size of the element normal to the longitudinal axis of the label, or the width, that is the size of the element along the longitudinal axis.

By maintaining the element width constant, variations in element length predominantly cause a change in amplitude of the received signal as illustrated in Fig 2a for the mechanically scanned

second harmonic system, and in Fig 2b for an electronically scanned system detecting the fundamental signal received from the label.

A set of linear test labels with 3 elements was manufactured with the element positions at 0mm, 1.5mm, 3mm along the longitudinal axis of the label. The element widths were 1mm and the length of the centre element varied between 1mm and 2mm. For each label, in Fig 2a, the peak position, the half peak width, the half peak separation and the amplitude difference between the half peaks is advantageously measured. The relative variation of these parameters of the central test element compared with the outer elements, which were maintained at constant length, may be plotted as shown in figure 2b. The measured central element amplitude (vampr), relative to the outer elements, shows a clear, near linear relationship to central element length. The measured central element relative position (vposr), width (vwidr) and separation (vsepr) parameters do not vary significantly with central element length, over and above the effects of experimental errors and imperfections in the manufacture of the test labels.

Similarly Fig 2b shows the relative variation of measured central element amplitude, position and width with element length when the test labels were measured in an electronically scanning reading system and shows a similar near linear relationship to the mechanically scanned reading method receiving second harmonic signals.

A label in which element length has been used to encode additional information is shown in Fig 3a, which shows a label 10 in which two element [with elements of one of two] lengths are used to modulate the elements in the code. The corresponding received signal is shown in Fig 3b in which a difference in

received amplitude from elements of different lengths can be observed. A typical design goal is to maximise the range at which a label may be read. A compromise is needed to maximise reading range for a 2-length label, at the same time as maximising the ability to discriminate the lengths of individual elements. In order to discriminate the length of label elements reliably, certain of these elements may be constrained to be at a known length to act as a reference. In the example illustrated in 3a, the 2 end elements, 12 and 13, of the label are maintained at maximum length to act as a reference. A design rule may also constrain a certain number of the inner elements to also be at maximum length. The reference elements may be at any a priori fixed position, or at a position determined by an a priori rule.

The half peak width, or half peak separation can be measured and, in the case of a reader detecting the second harmonic of the label signal, can be used to form an estimate of the velocity of the interrogation field, at the time when a particular element was scanned, Alternatively, in the case of a reader detecting the fundamental of the label signal, an estimate of the peak width can be used to form an estimate of the velocity of the scanning, at the time when the element was scanned. These estimates are typically K/w_est where K is some constant, and w_est is the estimate of width or half peak separation, as appropriate. The value of K typically depends on parameters of the reader, the element shape and the position of the element relative to the read antenna. Since K varies with element properties and to facilitate the estimation of the scanning dynamics, K may only be estimated to for elements of the same type based on the amplitude of the element signals.

The first step in processing a received signal

such as shown in Fig 1b or Fig 3b is to estimate the parameters of the peaks contained within the signal. This is achieved with the following steps:

1 The signal is delimited, that is the continuous received signal is broken up into a contiguous set of samples containing the received signal from one label, or a set of peaks that is likely to contain enough information to decode the label, in the case of non-registered repeating codes.

2 The signals from this delimited period are sorted into order of ascending magnitude. An indexed sort function, for example using the Quicksort method, such as index() (Numerical Recipes in C, second edition, ISBN 0 521 43108 5) is appropriate so that the original location of the point of any rank can be quickly found. The median value is found from the sorted data and provides a good estimate of the quiescent signal level. The median is subtracted from all signal points so that the quiescent level is close to zero.

3 The positive half peaks are found by working down from the largest signal in magnitude in the sorted data, testing the signal points as follows. If the test signal point is a peak, that is its adjacent signals are lower in magnitude it is estimated as a positive half peak, and its amplitude is interpolated by interpolation of the peak and its neighbouring points.

4 From each positive half peak found, the signal is scanned forward and backwards to find the points at which it falls below a defined magnitude relative to the peak, this is interpolated to a fraction of a sample period A typical magnitude value is 0.8 of the peak value found. The half peak width is estimated as

the difference in position between these points. The half peak position is estimated as the average of these two points. The half peak is rejected if it overlaps with any other pre-existing peak in the list, that is its width about its position interferes the width about any other peak position in the list. If it is not rejected, the half peak is appended to a list of half peaks.

5 The peak finding process stops when the magnitude of the next highest point falls below an absolute threshold, or when it falls below a defined fraction of the largest magnitude signal, for example 0.3 of the largest magnitude signal, or if a limit for the number of peaks is reached.

6 The negative half peaks are found by working up in magnitude from the lowest signal in magnitude in the sorted data, testing signal points of increasing magnitude. If the test signal point is a negative peak, that is its adjacent signals are higher in magnitude it is estimated as a negative half peak, and its amplitude is interpolated by interpolation of the peak and its neighbouring points.

7 For each negative half peak, the signal is scanned forward and backwards to find the points at which it increases above a defined magnitude relative to the negative peak, this is interpolated to a fraction of a sample period. The half peak width is estimated as the difference in position between these points. The half peak position is estimated as the average of these two points. The half peak is rejected if it overlaps with any other pre-existing peak in the list, that is its width about its position interferes the width about any other peak position in the list. If it is not rejected by this test it is then appended to a list of half peaks.

8 The negative peak finding process stops when the magnitude of the next highest point falls above an absolute threshold, or when it falls above a defined fraction of the largest magnitude signal, or if a limit for the number of peaks is reached.

9 The resultant list of positive and negative half peaks is then sorted into range order. This process will interleave the consecutive half peaks.

10 Merging range consecutive pairs of half peaks in the range sorted half peak list forms a list of double peaks. The amplitude of the merged double peak is the difference in amplitude of two half peaks being merged. The position of the merged double peak is the average of the two half peak positions. The width of the merged double peak is the average of two half-peak widths. The separation of the merged double peak is the difference between the two half peak positions.

The results of this half peak finding process are illustrated in Fig 4a which shows the half peaks found when the signal shown in Fig 3b is processed, and shows the output of step 9 above. These peaks are shown with a cross at the located position and estimated amplitude. Fig 4b shows the magnitude of the double peaks in amplitude units. In this case the amplitudes are negative since the first half peak is a negative going peak. The difference in peak amplitude between the full length and reduced length elements in the label can be clearly seen. Fig 4c shows the double peak separations versus double peak position showing the variation across the scanning of the label.

In the case of a fundamental signal where there is just one peak per element, such as that shown in Fig 1d, a simpler process is may be used, missing steps 6

to 10 above since there is no need to find and merge double peaks.

There are N label elements positions whose centres are located at X_1 .. X_N along the longitudinal axis of the label, and whose position we wish to estimate. It is assumed that X_1 is at position 0.0 and that the final element, X_N is at the known position of corresponding to the length of the label L.

The peak list as described above contains estimates of the sample number, and hence times T_i at which the reader detected a double peak. For each element i, the time T_i. is simply the position in samples where the peak was measured multiplied by the sample period, which is the reciprocal of the sampling rate.

By using the estimated double peak width or double peak separation for each of the N peaks denoted W_i a velocity estimate for the i^{th} peak is $VE_i=1/W_i$ at time T_i .

The order M velocity function of time is modelled by a polynomial function. M is chosen to allow sufficient degrees of freedom to model the dynamics of label motion sufficiently accurately. It can range from 1 (constant acceleration model) upwards .

$$VF(t,M)=a_0+a_1t+a_2t^2+a_3t^3+\ldots a_Mt^M$$

where {a} are a set of polynomial coefficients to be determined.

The squared error for velocity estimate VE_i at time T_i is $E_i^2=(VE_i-VF(T_i,M))^2$

The total sum of the squared errors is $ES(M)=E_1^2+E_2^2+\ldots+E_N^2$ which is minimised by varying the M+1 parameters $a_0,a_1\ldots a_M$ This is achieved by the method of

least squares to find the optimum parameters in the least squares sense.

Define the matrix X to contain the T_i values raised to a given power. For example column 0 row i of X contains T_i^0 and column M row 4 of X contains T_4^M . Define the vector V to contain the velocity estimates VE_i . For example the element in row 4 of V contains VE_4

Some linear combination of the columns in X will be closest to the vector V in the least-squares sense. The coefficients of this linear combination will be the coefficients of the best-fitting polynomial. If A is the vector of length M+1 that holds the coefficients, the problem is to find the value for A that gives the best "near-solution" to the system of equations XA= V. If the columns of X are independent, the best choice for A is given by:

$$A=(X^TX)^{-1}(X^TV)$$

Where " ^{T} " represents matrix transpose and " $^{-1}$ " represents matrix inversion. The coefficient a_i is then the element from row i of A. This may be efficiently calculated by using methods such as LU decomposition, for examples the functions ludcmp() and lubksb() (Numerical Recipes in C, second edition, ISBN 0 521 43108 5)

This process is illustrated in Fig 4d where the velocity estimates W_i that were computed from the double peak separation data of Fig 4c are shown, those points marked "full data" contain the velocity estimates from all the peaks. In this example case, only the estimates from peaks with high amplitude, see Fig 4b, are selected for velocity fitting. These selected points are marked "Data points used in fit". If the label known a priori to have elements of the same size then all elements would have been used. A least squares fit

of order 2 was used and the continuous line shows the estimated velocity function as a function of sample number. A least squares fit of order 1, 2 or 3 is typically sufficient to model the velocity function with sufficient accuracy.

Error metrics are computed to allow the decoding algorithms to assess the quality of the read. A useful normalised velocity error metric, denoted evel, to quantify how well the velocity function fitted the data observed is defined. It is the sum of squares of the normalised error defined as :

$$evel=sum(E_i^2/VE_i^2) \text{ for } i=1..N$$

The vector A could also be estimated by an iterative minimisation procedure such as Powell's method.

The above procedure can be repeated for varying model order M on the same data in order to find the best approximation. Preferably this is the solution with the smallest number of degrees of freedom, that fits the data read by the reader with the lowest error metrics.

Analytical interrogation and normalisation of tag length

The velocity fit function is $VF(t,M)=a_0+a_1t+a_2t^2+a_3t^3+\ldots.+a_Mt^M$ This may be analytically integrated to find the positional fit function

$$P(t,M) =Q+a_0t+(1/2)a_1t^2+(1/3)a_2t^3+\ldots.+(1/(M+1))a_Mt^{M+1}$$

where Q is an arbitrary constant of integration, set to zero.

We know that the position of label element 1 is at 0.0.

We also know that the position of element N, the last element scanned is L, the length of the label. The final estimates of element position are:

$$XE_i = L \ . \ (P(X_i\ ,\ M)-P(X_1,M))\ /\ (P(X_N\ ,M)-P(X_1,M))$$

Binning of data

There are N positional estimates XE_1 to XE_N from which N-1 gaps may be estimated.

Typically the gaps have the minimum gap subtracted, and are divided by the minimum gap, to give a real number representing the number of gap increments. The nearest integer is then taken to represent the gap for subsequent decoding. This can be expressed as:

The N-1 normalised gaps R_j are calculated by
$R_j=(XE_{j+1}-XE_j\text{-Minimum\_Gap})/\text{Gap\_Increment}$ for $j=1...N-1$

The normalised gaps are then converted to their nearest integer representaton
$G_j= \text{int}(R_j+0.5)$ for $j=1...N-1$, where int(x) means the truncated integer portion of x.

In this way, the gaps between each adjacent pair of magnetic elements can be defined by A + mG, wherein A is a first fixed value; m is an integer (which may be zero); and G is a second fixed value

One useful error metric, denoted emax, is defined as the maximum magnitude of the difference between G_j and R_j .Another useful error metric, denoted eav, is the average magnitude of the difference between G_j and R_j.

Fig 4e shows the gap sequence data R_i computed from the data in Fig 4a-d, and shows the close correspondence or "snapping" to an integer grid, giving a high confidence that the gaps have been correctly measured. The gap sequence in this case is 3,2,2,1,7,0,0,2,1 .

Enumeration algorithms

Depending on the coding scheme used, the gap sequence is enumerated to a unique decoded value. Various codes exist that have different properties for example those codes allowing read direction to be determined, or those that allow non-registered operation, that is allowing the gap sequence to start at any position, for example a portion of a repeating gap sequence. The code may be determined a priori, or diagnosed by examining the read signals for the number of material elements present, or by estimating the sum of the gap numbers. It is preferable to determine this beforehand in order to minimise the chance of misinterpreting a given set of read data.

For certain codes, the number of elements in the label may be one of a range of possible values, with fixed label length in order to increase the number of possible codes.

The direction finding codes are preferably used where amplitude coding is used to allow the amplitude information to be associated with the correct element.

Amplitude threshold estimation of elements

Where it is desired to detect the size of the received element signal, for example when the elements may be of two or more sizes, reference elements may be placed in

the set of elements used to make the label. In one embodiment, the end elements are constrained to be the largest element size to act as a reference. Other embodiments may place reference elements that have some unique characteristic, or may be identified by an a priori rule.

The amplitudes are measured and used to compute normalised amplitudes. This is because the reference elements may be significantly different in magnitude. This may be due to the scanning process varying the distance or angle of the read head from the label during the read, or other factors.

The estimates of element position XE_i may be used for linear interpolation of the reference amplitude along the label. The reference amplitude predicted at the estimated position of the element divides the measured element amplitudes to normalise the amplitudes. The normalised amplitudes should be nominally 1.0 for an element the same size as the reference element.

Threshold levels are set to provide discrimination between the possible element amplitudes and to classify the amplitude of the element into one of an alphabet of values. For example if there are two values then the amplitude is either high or low. For example a half length element may have an amplitude, on average, half the reference amplitude ie 0.5. In this case, the threshold level should be set to approximately 0.75 in order to determine if the element was full length or half length.

Preferably a code is used which enables the direction of reading of the label to be determined by the sequence of gaps that resulted. In this case the

elements can be uniquely identified and it is known which element of the label to associate with the decoded amplitude information.

In the case of the label data shown in Fig 4b, denoting the amplitudes of the signals from the elements as "H" for high amplitude and "L" for low amplitude, the elements are categorised as H,L,H,L,H,L,H,L,L,H. A larger alphabet of elements could be used by using a label with more possible shapes, for example. The categorisations are then converted to decoded data.

A typical scheme allows the inner elements only to contain data, ignoring the end elements, which are references, and maps H to a logical 0 and L to a logical 1 so that the binary data word from the example data would be 10101011. In this scheme up to 256 amplitude codes can be represented from 8 inner elements. Preferably the codes used are constrained to ensure that a certain number of elements in the label, for example 4 are at full length to facilitate velocity estimation. If this constraint is used, the number of amplitude codes is reduced by 37 to 219 in this case.

An amplitude error metric eamp is defined which is the normalised amplitude difference between the largest half length element diagnosed to the smallest full length element diagnosed. If there is no half-length element diagnosed, eamp is defined as the smallest full length element amplitude. In a label containing different sized elements, a large value for this metric suggests a clear discrimination in amplitude between elements of different types. Smaller values indicate increasing risk that an element may be categorised as the wrong amplitude.

Error Metrics

The error metrics defined: evel, emax, eav and eamp can be used to determine the read quality. evel, emax and eav are preferably small and eamp high. Independent thresholds for these quantities are independently established. These thresholds are based on measured values for many labels in many read operations over the range of reading ranges and scanning dynamics expected in an application. This is done to minimise the probability of a wrong code at the same time as maintaining a high probability of a correct read.

During the read decoding process, if the computed error metrics are higher than the threshold value in the case of evel, emax and eav then the read is rejected. If the error metric is lower than the threshold in the case of eamp then the read is rejected.

CLAIMS

1. A method of decoding an information carrier comprising a plurality of magnetic elements supported by, or incorporated in, a substrate, wherein the elements are of substantially the same width and wherein the relative positions of said magnetic elements represents the information encoded by the information carrier, the method comprising the steps of:

i) applying an interrogation signal to the information carrier so that each of the magnetic elements are subjected, in turn, to the interrogation signal;

ii) detecting the response signal of each of the magnetic elements to said interrogation signal;

iii) processing each response signal detected in ii) so as to determine an estimate of the relative velocity between the interrogation signal and each of the magnetic elements; and

iv) estimating the dynamics of motion between the interrogation signal and the information carrier, by consideration of the processed signals obtained in iii), so as to determine the relative positions of the magnetic elements.

2 A method according to claim 1, wherein said magnetic elements comprise high permeability, low coercivity material having an easy axis of magnetisation.

3. A method according to claim 1 or 2, wherein said interrogation signal comprises regions of high saturating magnetic field contiguous with regions of zero magnetic field.

4. A method according to any preceding claim, wherein the frequency of the detected response generated by said magnetic elements is a harmonic of the interrogation signal.

5. A method according to any preceding claim, wherein the frequency of the detected response generated by said magnetic elements is the second harmonic of the interrogation signal.

6. A method according to any claim 4 or 5, wherein a graphical representation of the response signal is obtained by plotting the amplitude of the detected signal against time, wherein the presence of a magnetic element is indicated by two half peaks of opposite polarity in the detected response signal.

7. A method according to claim 6, wherein the half peaks in the detected response signal are identified by the following steps:

i) obtaining a contiguous set of sample points from the detected response signal;

ii) sorting the samples points into an order of ascending magnitude;

iii) finding the median value from the sorted samples and subtracting this value from each of the sample points;

iv) testing the sample points in order to identify the peaks, wherein a positive polarity half peak is identified by the presence of lower magnitude signals either side of the signal point being tested, and a negative polarity half peak is identified by the presence of higher magnitude signal either side of the signal point being tested.

8. A method according to claim 7, wherein the relative

velocity between the interrogation signal and each of the magnetic elements is determined by:

i) determining the two positions either side of the peak at which the amplitude of the detected response signal is a predetermined fraction of the peak amplitude value; and

vi) determining the distance between these two positions to give the half peak width.

9. A method according to claim 6 or 7, wherein an estimate of the relative velocity between the interrogation signal and the information carrier during its interaction with each of the magnetic elements is determined by measuring the separation between the two half peaks of opposite polarity.

10. A method according to any one of claims 1,2 or 3, wherein the frequency of the detected response generated by said magnetic elements is the fundamental frequency of the interrogation signal.

11. A method according to claim 10, wherein a graphical representation of the response signal is obtained by plotting the amplitude of the detected signal against time, wherein the presence of a magnetic element is indicated by a peak in the detected response signal.

12. A method according to claim 11, wherein the peaks in the detected response signal are identified by the following steps:

i) obtaining a contiguous set of sample points from the detected response signal;

ii) sorting the samples points into an order of ascending magnitude;

iii). finding the median value from the sorted

samples and subtracting this value from each of the sample points;

iv) testing the sample points in order to identify the peaks, wherein a peak is identified by the presence of lower magnitude signals either side of the signal point being tested.

13. A method according to claim 12, wherein an estimate of the relative velocity between the interrogation signal and each of the magnetic elements is determined by:

i) determining the two positions either side of the peak at which the amplitude of the detected response signal is a predetermined fraction of the peak amplitude value; and

ii) determining the distance between these two positions to give the peak width.

14. A method according to any one of claims 6 to 13, wherein the velocity of the interrogation signal, with respect to each magnetic element, is determined from the values of each of the peak or half peak widths.

15. A method according to any preceding claim, wherein the velocity function of the interrogation signal is modelled by a polynomial function, the coefficients of which are determined by the estimates of the velocity of the interrogation signal at each magnetic element.

16. A method according to claim 15, wherein said mathematical function is integrated with respect to time so as to determine the size of the gaps between each of the magnetic elements.

17. A method according to any preceding claim,

wherein the size of the measured gaps between each adjacent pair of magnetic elements are modelled by A + mG, wherein A is a first fixed value; m is an integer (which may be zero); and G is a second fixed value.

18. A method according to any preceding claim, further comprising the step of decoding a variation in length of the magnetic elements, wherein the amplitude of the detected signal response is directly related to the length of the element.

19. A method according to claim 18, wherein the length of at least one of the magnetic elements is or are known, thereby acting as a reference element, with respect to which the lengths of the other magnetic elements can be determined.

20. A method according to any one of claims 15 to 18, further comprising the step of determining an error metric of the velocity function.

21. A method according to any one of claim 17, further comprising the step of determining an error metric of the measured gaps between the magnetic elements compared with the gap widths as modelled by A+mG where m is a decoded integer from each measured gap.

22. A method according to any one of claims 15 to 18, further comprising the step of determining an error metric of the amplitude of the magnetic response.

23. A method according to any one of claims 20, 21 or 22, wherein the decoded information is rejected if the error metric is found to be higher than a threshold level.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 February 2001 (15.02.2001)

PCT

(10) International Publication Number
WO 01/11541 A1

(51) International Patent Classification[7]: G06K 7/016

(21) International Application Number: PCT/GB00/03006

(22) International Filing Date: 4 August 2000 (04.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
9918657.9 6 August 1999 (06.08.1999) GB

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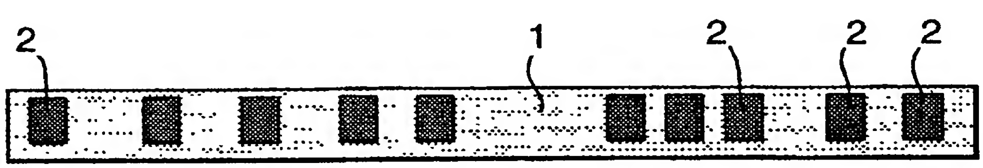
(81) Designated States *(national)*: JP, US.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*
— *With amended claims.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: CODED LABEL INFORMATION EXTRACTION METHOD



(57) Abstract: A method of interpreting coded information carriers (1) is disclosed wherein a plurality of magnetic elements (2) supported by, or incorporated in, a substrate, are interrogated wherein the relative positions and/or physical dimensions of said magnetic elements represents the information encoded by said information carrier, the method comprising the steps of: i) applying an interrogation signal to each of the elements of said information carrier; ii) detecting the response of said magnetic elements to said interrogation signal; iii) processing the response detected in ii) so as to determine an estimate of a mathematical function which defines the relative velocity between the interrogating signal and each of the magnetic elements, from which mathematical function the relative positions and/or the relative physical dimensions can be determined.

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1/5

Fig.1a.

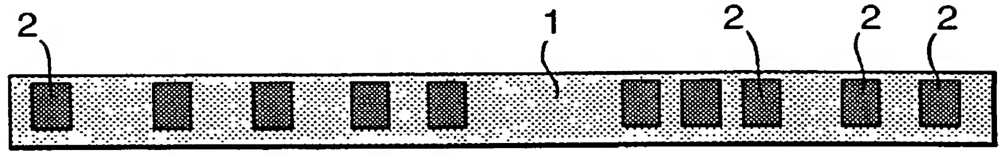


Fig.1b.

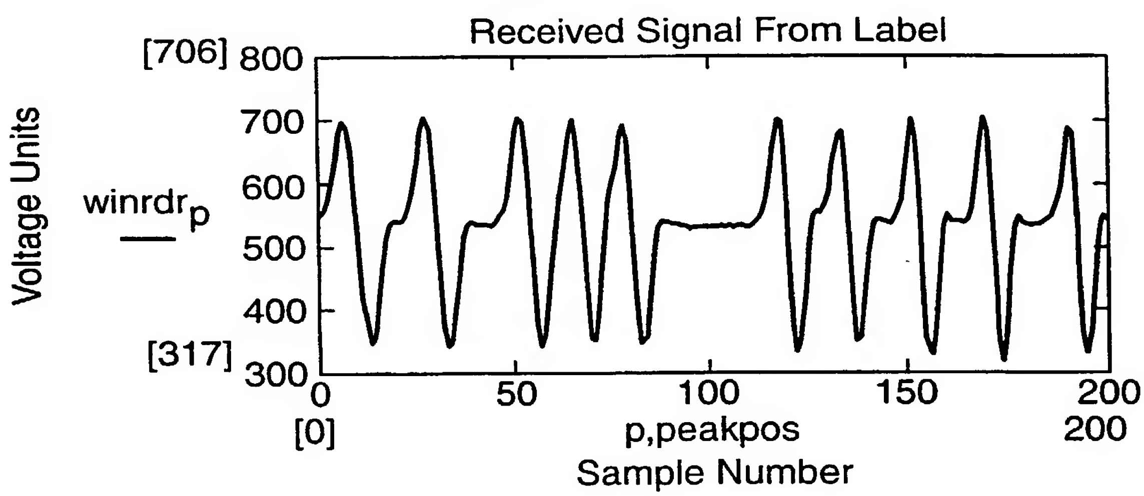


Fig.1c.

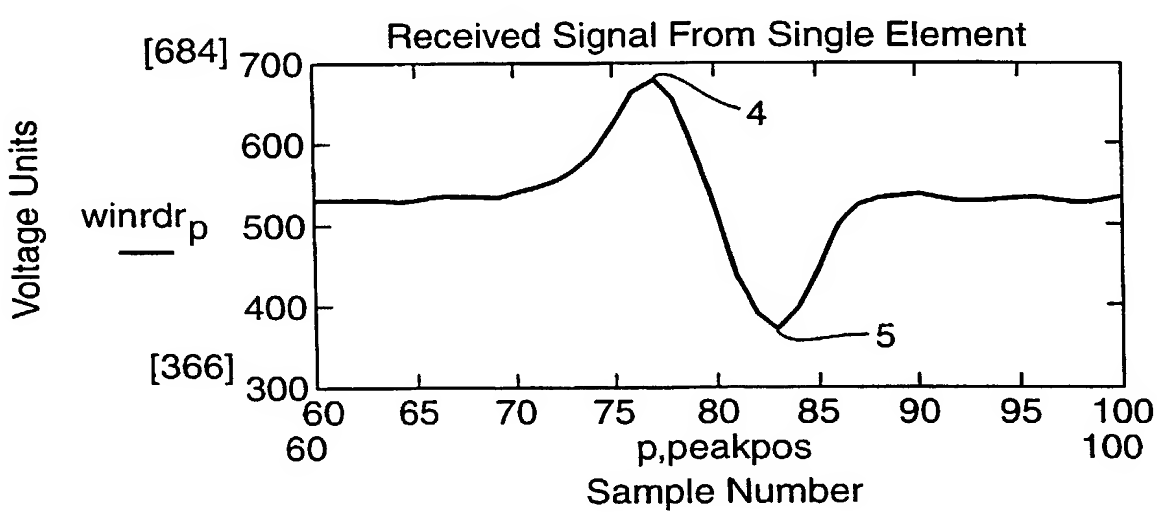


Fig.1d.

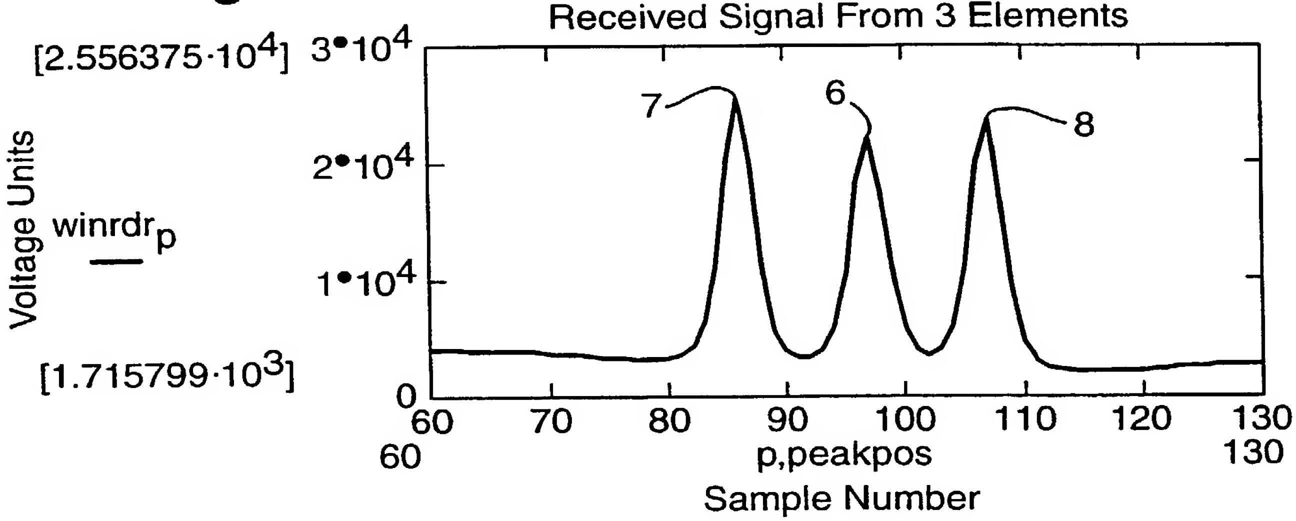


Fig.2a.

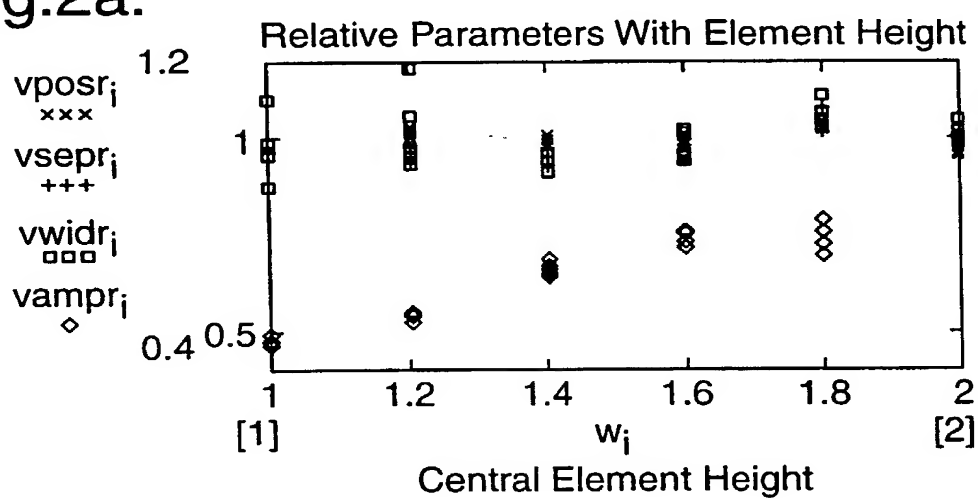


Fig.2b.

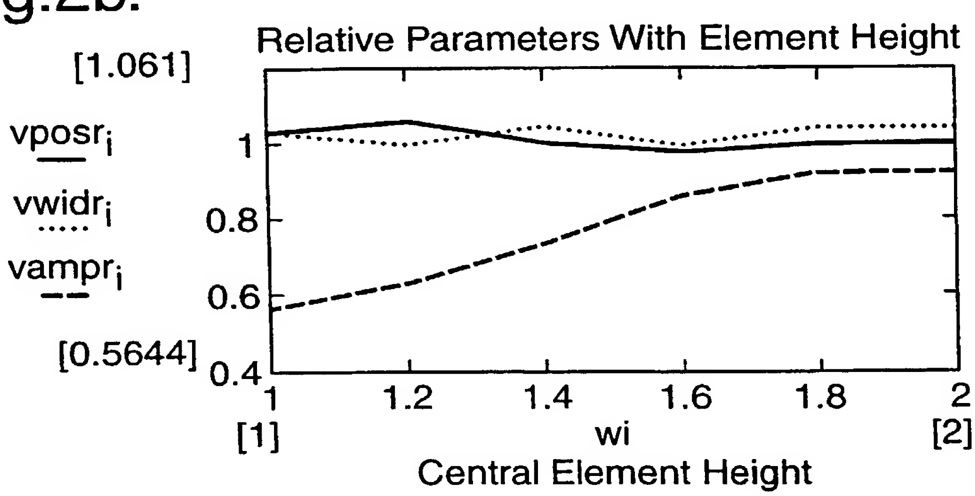


Fig.3a.

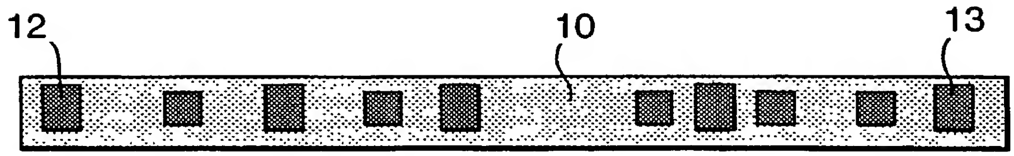
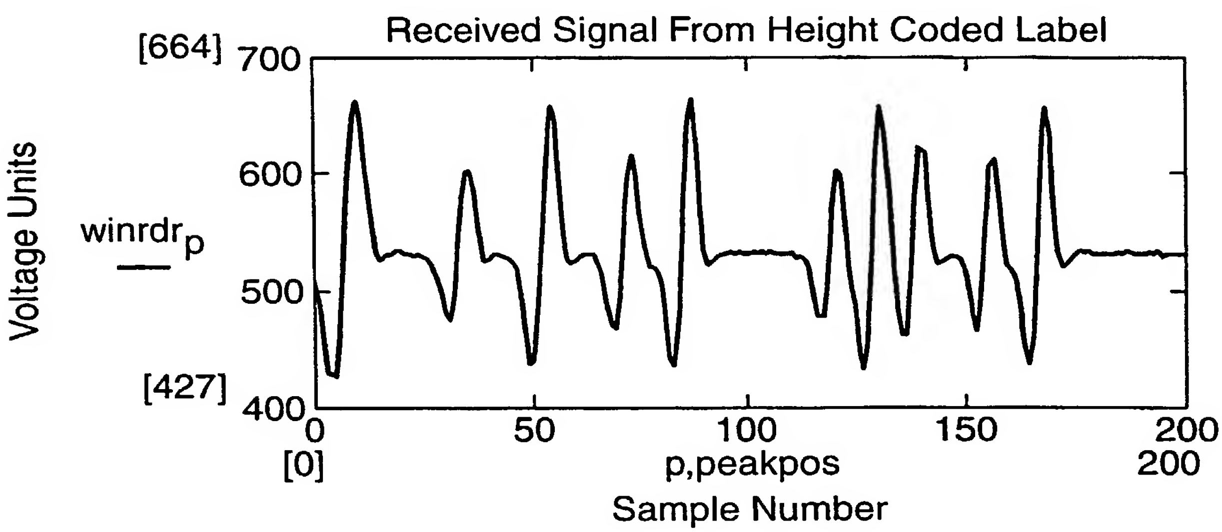

12
10
13

Fig.3b.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500
[427]
400
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50
100
150
200
[0]
p,peakpos
200
Sample Number

Fig.4a.

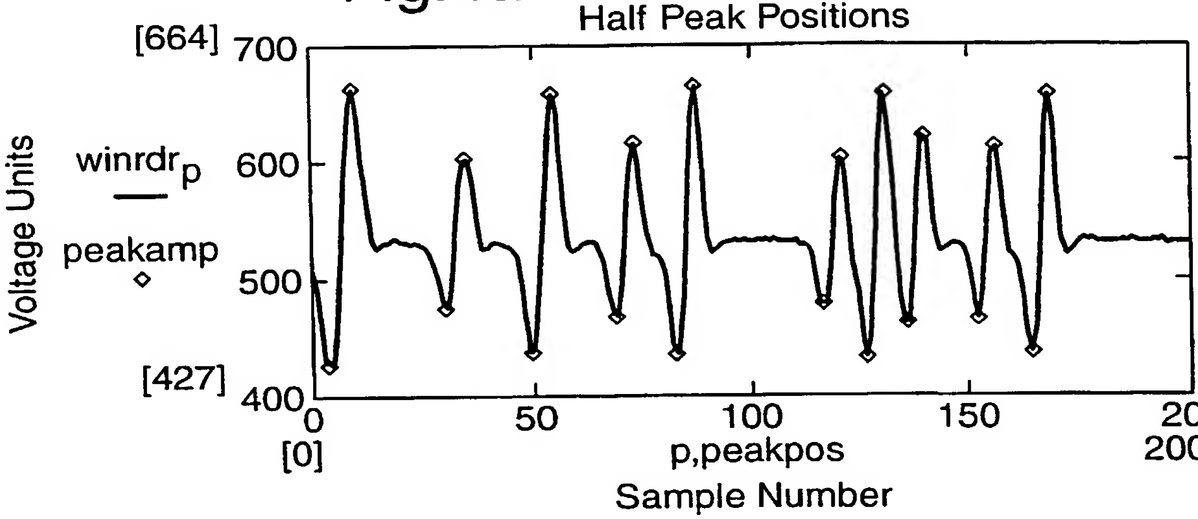
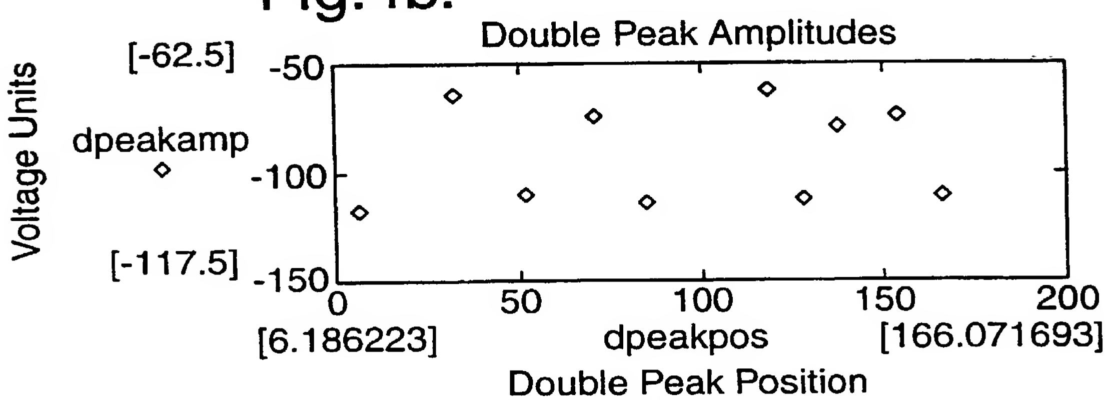


Fig.4b.



Element Amplitudes Categorised: H,L,H,L,H,L,H,L,L,H

Fig.4c.

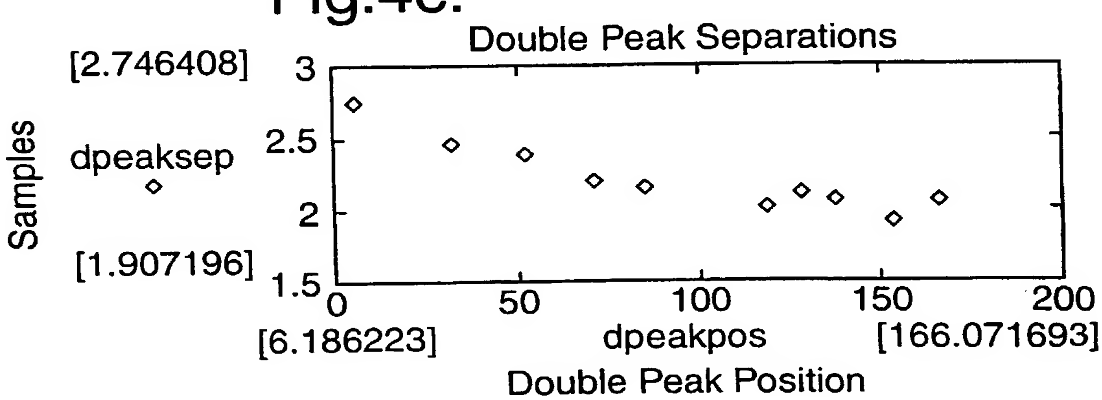
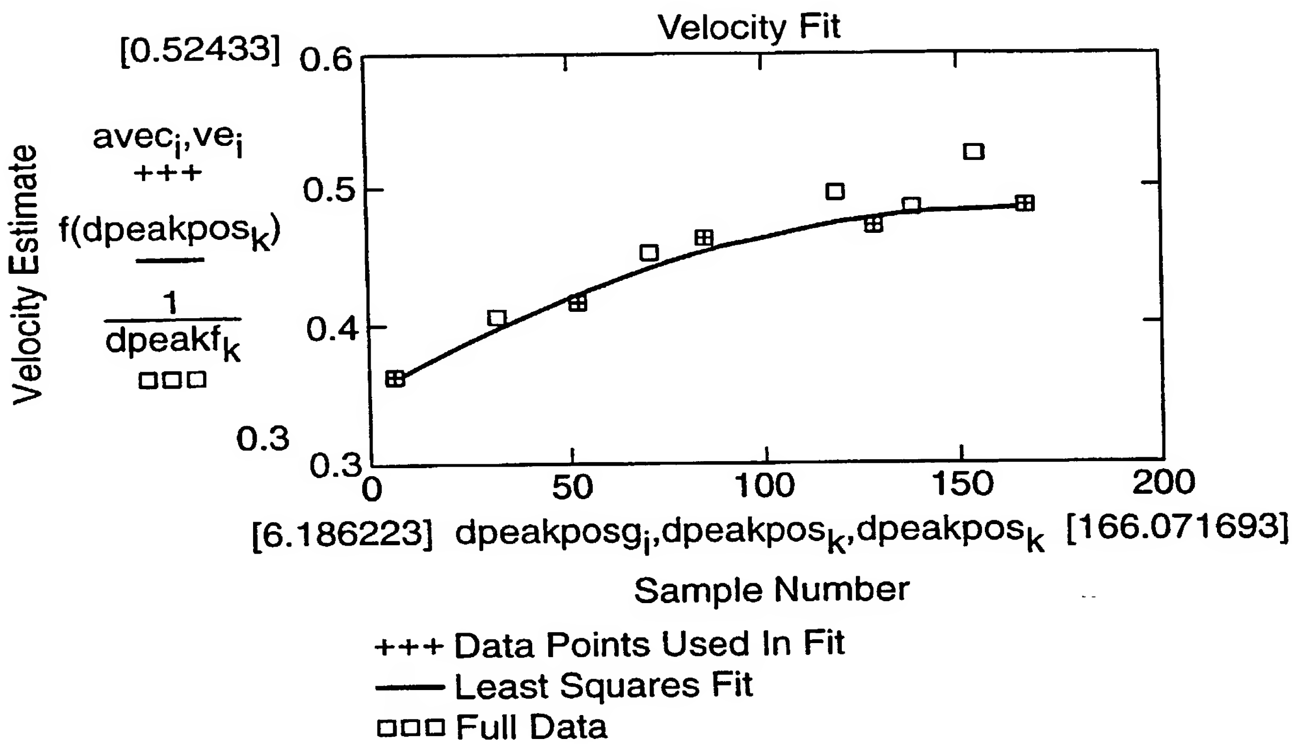


Fig.4d.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0.5
0.4
0.3
0.3
Velocity Estimate
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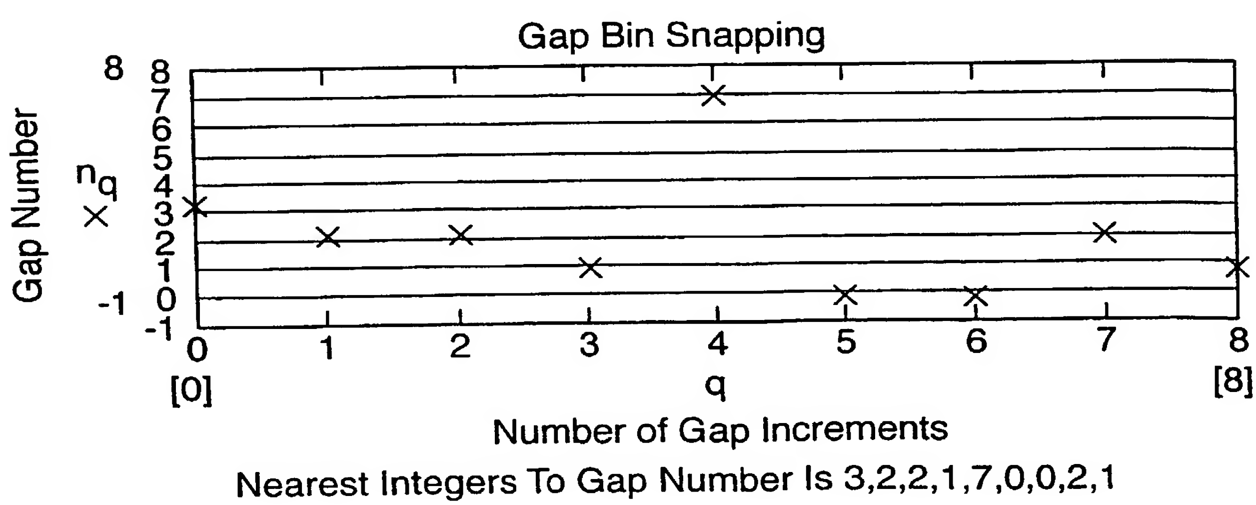
+++
f(dpeakpos$_k$)
1
dpeakf$_k$
□□□
0
50
100
150
200
[6.186223] dpeakposg$_i$,dpeakpos$_k$,dpeakpos$_k$ [166.071693]
Sample Number
+++ Data Points Used In Fit
Least Squares Fit
□□□ Full Data

Fig.4e.


Gap Bin Snapping
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-1
Gap Number
n$_q$
×
8 7 6 5 4 3 2 1 0 -1
0 1 2 3 4 5 6 7 8
[0]
q
[8]
Number of Gap Increments
Nearest Integers To Gap Number Is 3,2,2,1,7,0,0,2,1

PTO/SB/01 (10-01)
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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☒ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	8420/86130 (new)
First Named Inventor	Matthewson, Peter
COMPLETE IF KNOWN	
Application Number	10 /048,077
Filing Date	01/23/2002
Art Unit	Unknown
Examiner Name	Not assigned

As the below named inventor, I hereby declare that:

My residence, mailing address, and citizenship are as stated below next to my name

I believe I am the original and first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled.

Coded Label Information Extraction Method

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) 08/04/2000 as ~~United States Application Number or~~ PCT International

Application Number PCT/GB00/03006 and was amended on (MM/DD/YYYY) 01/23/2002 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application

I hereby claim foreign priority benefits under 35 U S.C 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
9918657.9	Gr. Britain	08/06/1999	☐	☐	☒
PCT/GB00/03006	PCT (GB)	08/04/2000	☐	☐	☒
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto·

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Direct all correspondence to: [x]	Customer Number or Bar Code Label: 24628	OR	[X] Correspondence address below

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon

NAME OF SOLE OR FIRST INVENTOR : [ ] A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Peter	Family Name or Surname	Matthewson
Inventor's Signature	x P. Matthewson	Date	13th May 2002
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NAME OF SECOND INVENTOR: [ ] A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])		Family Name or Surname	
Inventor's Signature		Date	
Residence: City	State	Country	Citizenship
Mailing Address			
City	State	ZIP	Country

[ ] Additional inventors are being named on the ____supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto